BRITISH STANDARD

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Guide to

The accommodation and operating environment for Information Technology (IT) equipment

ICS 35.020

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee IST/22, Accommodation and environment for computer equipment, upon which the following bodies were represented:

Association for Payment Clearing Service (APACS)
British Telecommunications plc
Chartered Institution of Building Services Engineers
Electricity Association
Federation of the Electronics Industry
HEVAC Association
IBM United Kingdom Ltd.
ICL CPS
Institute of Management
Institution of Electrical Engineers
National Physical Laboratory
Open University
Society of Environmental Engineers
Sun Alliance Insurance Group
Trades Union Congress

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Contents

Foreword

This British Standard has been prepared by Technical Committee IST/22. It supersedes BS 7083 : 1989, which is withdrawn.

This British Standard is designed to aid in the planning, installation and maintenance of IT accommodation and to give guidance to IT users at all levels. It has been written to assist individuals or groups such as those listed below, in their role as clients, users' agents, and others defining users' requirements:

directors, managers, architects, consultants, contractors, designers, engineers, IT staff, at all levels of employment in all types of organizations incorporating or making provision for IT equipment.

This standard does not aim to cover the whole subject exhaustively, but to provide a guide to relevant standards, legislation and recommendations from other bodies involved in the installation and maintenance of IT accommodation. Manufacturers or suppliers should be consulted about specific details of IT equipment.

As a guide, this British Standard takes the form of recommendations and general or background information. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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Guide

Introduction

This standard provides an executive summary of the principal factors to be considered when planning the accommodation of IT equipment, with cross–references to more detailed information, in the form of:

a) commentary on the requirements of people and equipment;

b) commentary on typical classes of accommodation;

c) recommendations for special environments and circumstances, e.g. clean rooms, anticipated loadings;

d) guidance on interpretation of recommendations from other bodies.

If used as a 'what to look out for' guide in the context of the specific installation, building or environment concerned, users of this British Standard should find sufficient help to enable them to decide firstly which factors or conditions are appropriate to their particular circumstances and then which of the options are most suitable for them and how they can be implemented to achieve satisfactory solutions.

Users of this standard should understand that this British Standard cannot and does not make a single set of recommendations for the 'ideal' situation, nor composite sets of recommendations for different 'grades' of accommodation or environment. In general, opportunities should be taken to discuss particular problems with the supplier, manufacturer or independent professional advisor.

Consideration of legislation is an essential part of this process. Employers have responsibilities to provide and maintain suitable conditions and it is in their commercial interests to do so. These 'suitable conditions' effectively constitute user requirements and should be included in the client's purchasing brief for the design, construction and maintenance of the workplace.

Legislation is normally structured at three levels:

i)	primary legislation:	Acts of Parliament, describing the broad aims;
ii)	secondary legislation:	Statutory Instruments and Orders, expanding where considered necessary upon particular aims of Acts, describing what is required;
iii)	tertiary legislation:	documents, agreed by consensus, drawn up by recognized national and international standards bodies, and whose subject content is referred to in primary and secondary legislation.

Legislation is frequently expressed in functional terms, rather than prescriptive terms, thereby facilitating the development of innovative systems to achieve the objectives. Standards provide a means at a tertiary level of demonstrating compliance with the objective.

It is essential that owners, procurers and providers of accommodation are aware of such legislation. Much legislation affecting the workplace and buildings is enacted under criminal law.

1 Scope

This British Standard gives guidance on the accommodation and operating environment within which Information Technology (IT) equipment and associated services are installed, including advice on:

a) construction and accessibility;

b) environmental conditions;

c) electrical power requirements;

d) operational safety and security.

It applies to IT equipment, whether portable or fixed, in enclosed or controlled environments typically occupied by people not exposed to dirty or contaminated conditions and it covers, therefore, conditions typically found in offices, schools and domestic environments.

This British Standard is intended to give guidance primarily to those concerned in planning and using accommodation for IT equipment, not for equipment manufacturers.

Many of the recommendations are also likely to be applicable to installations exposed to worse conditions, such as in industrial environments, construction sites or laboratories using hazardous materials, or environments that are not stationary. This standard does not include guidance on the additional requirements needed in such circumstances to safeguard individuals or equipment.

Similarly, while many references take account of conditions specific to the UK, the guidance contained in this standard may be applicable outside the UK.

This British Standard does not encompass all the provisions needed in the placement of contracts or provision of tenders associated with any desired accommodation or environment, although some guidance is given.

2 References

2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 33. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on pages 33-39, but reference should be made to the latest editions.

3 Definitions

For the purposes of this British Standard, the definitions given in BS ISO/IEC 2382-1 for IT terms and in BS 6100 : Part 0 for building and civil engineering terms apply together with the following.

3.1 Information Technology (IT)

Technology of recording, storing, transmitting, processing and displaying of data, also referred to as Information and Communication Technology (ICT).

3.2 IT equipment

Physical equipment used for the recording, storing, transmitting, processing and displaying of data.

3.3 fresh air

Air taken from outside a building, which is likely to be free of any impurity which could be offensive, contaminate or cause ill health.

3.4 air conditioning

System which fully controls the environmental conditions, i.e. temperature and humidity, in an enclosed space. Such a system may also include control of particulate contamination, in terms of size and concentration.

3.5 class 1 equipment

IT equipment in which protection against electric shock does not rely on basic insulation only, but which includes means for the connection of exposed conductive parts to a protective conductor in the fixed wiring of the installation.

3.6 hold up characteristics

Ability of the IT equipment to continue working through short term voltage reduction.

3.7 hold up time

Time in minutes in which IT equipment can continue working through short term voltage reductions or loss of the electricity supply.

3.8 bunded area

Area surrounded by walls of appropriate height to retain water or other liquid.

3.9 design maintained illuminance

Minimum illuminance which has to be maintained throughout the life of the lighting installation.

3.10 motor alternator

Motor, driven by the incoming mains supply, and mechanically coupled to a controlled alternator.

3.11 competent

In possession of the necessary technical expertise, training and experience to carry out the job in hand safely, with due regard to good working practice.

3.12 teleworking

Activity where people spend a significant part of their working time using IT equipment whilst working from a designated working area in their home premises or in remote locations, which has been agreed with the employer.

3.13 foot-print topology

Outline of equipment indicating its shape and space requirements.

NOTE. Commonly referred to as plan views.

3.14 failure mode

Situation caused by cessation of normal operations, e.g. the failure of the equipment, network or power supply.

3.15 barrier box

Box with a fusible link and other components as required to prevent transmission of lightning surges or other induced voltage from damaging equipment or personnel.

3.16 as built drawings

Record drawings, showing construction and installation work, used for the maintenance or future modification of the building and its services.

4 Planning and implementation

4.1 General

The foundation for successful implementation of any IT project depends on its planning and the identification of business objectives.

An integral part of the plan for the project should be the preparation of accommodation and operating environment for the equipment.

The following considerations are central to the development of the plan:

a) activities to be implemented;

b) rationale behind decisions;

c) location and macro-economic considerations;

d) timing and phasing;

e) key personnel and interested parties;

f) project methodology.

The stages of planning and implementation are covered in **4.2** to **4.5**. For further information on project management, see BS 6079.

4.2 Project inception

4.2.1 *Initial brief*

It is important to establish the objectives for the project as early as possible. This should include consideration of the requirements of all interested parties.

A statement of the operating environment for the IT equipment should be set out in clear terms, identifying any requirements for future modifications, upgrade or maintenance procedures.

NOTE. See Technical Memorandum TM 17: Maintenance Management for Building Services – CIBSE [10].

Each IT equipment option imposes specific environmental requirements on the IT equipment, and any resolution may impact on future equipment changes. Therefore user requirements including the projected life of the equipment, safety and business continuity should be identified at the inception stage of the project.

NOTE. The DISC BuyIT Guidelines give guidance to organizations on improving the way that they specify, acquire and benefit from IT equipment.

4.2.2 *Feasibility study and development of brief*

All potential solutions for the accommodation and operating environment should be assessed in terms of practicability and cost. The fullest possible use of this standard and all referenced documents should be made in acquiring this information before any decisions are made.

The advice of professionally qualified experts, equipment manufacturers and users should be sought, where appropriate.

A statement of requirements for accommodation and operating environment for the selected IT system, possibly including some alternative solutions, should be produced at this stage.

Consideration should also be given to security in the location of the IT equipment at this stage.

In some cases, a list of requirements suitable for more than one IT system may be possible. However, since the cost of changes from the original estimates increases in an exponential fashion as they are introduced through the design and construction stages, it is preferable that the requirements are exactly the same for the different IT systems.

Where the project is concerned with the accommodation and operating environment for unknown IT equipment, it should meet the requirements of a typical equipment loading, whether structural, environmental or electrical, e.g. in terms of uniform distribution or areas of high localized loads. The possibilities for different IT systems should not be limited by the choice of design and operating parameters.

Where existing buildings are to be modified, refurbished or updated, the removal of any existing services made redundant by the project should be considered in the feasibility study, to facilitate maintenance and future modifications to the services or IT systems. The items considered for removal should include equipment, pipework, ductwork and especially power and data cables.

The options considered for this accommodation and operating environment should include:

– methods of procurement;

– life cycle operating costs;

– maintainability;

– expansion;

– integration.

As soon as a firm decision has been made to proceed with the project, a Planning Supervisor should be appointed, and an outline brief for design should be produced.

NOTE. Attention is drawn to the Construction (Design and Management) Regulations [16] at this stage. The definition of 'construction' under these regulations is extremely wide, and the advice of a health and safety professional should be sought in case of uncertainty.

4.3 Design development

4.3.1 *Conceptual design*

In the conceptual design stage the brief for design should be developed into a firm proposal for the project which should fully explore all the options for meeting the requirements.

A design team and its leader should be appointed at the start of this stage. Care should be taken to ensure that this team has the appropriate experience to cater for the requirements of the IT system. It is particularly important that the design team leader is familiar with projects for the accommodation and operating environment for IT systems. The constituents of the design team will vary with the complexity of the project.

At this stage firm decisions on the method of procurement of the accommodation and operating environment should be made. The guidance of appropriate construction professionals is invaluable in making this decision.

4.3.2 *Detail design*

Development of the detail design should be combined and coordinated with all other project activities.

A cost effective and timely project should be managed with care and any changes to the requirements controlled by an agreed process. Without this control costs can escalate and may easily exceed the budget both for the design and the construction.

A firm agreed design for the provision of the accommodation and operating environment for the IT system should be produced at this stage.

4.3.3 *Construction information*

The project design should form the basis of the documentation necessary for the project construction and for awarding of the contract for the work.

When work is done in-house or when a design and build solution is sought, there is often a perception that costs will be reduced by limiting the detail given to tradespeople to that produced in the design stage. Whilst this method of working can be successful for a simple project, it is probable that costs and time-scales will escalate if the details and coordinations of the various operations are not planned. Where doubt exists, it is far better to develop the design in detail, as this will assist in the management of cost, particularly that associated with uncontrolled changes.

A developed design which includes adequate information for construction, installation and testing to be carried out without further design input should be produced at this stage.

4.4 Procurement and implementation

4.4.1 *Tender and contract documentation*

The type and extent of documentation needed varies with the size and complexity of the project and with the selected method of procurement. Accurate and complete documentation facilitates the preparation of cost estimates and prices.

The advice of construction professionals should therefore be obtained before the preparation of the documents.

If competitive tenders for the work are to be sought from potential contractors, care should be taken to follow accepted fair procedures.

NOTE 1. Attention is drawn to the Construction (Design and Management) Regulations [16]. The appointed Planning Supervisor should consult the Managing Construction for Health and Safety Approved Code of Practice (ACOP) [49] for the regulations at this stage.

NOTE 2. Some organizations are required to adhere to set procedures in the tendering process, e.g. under the Utilities Supply and Works (Contracts) Regulations [43].

The minimum documentation needed before work commences should be as follows:

– design drawings;
– specification of the work;
– Health and Safety Plan;
– where contractors are employed, the agreed contract, including price information as well as the items listed above.

4.4.2 *Installation, testing and commissioning*

Construction should be in accordance with the design specification, with close supervision and careful attention to coordinate the various operations.

It is essential that changes are minimized and strictly controlled in order to complete the project within budget and schedule.

Where changes are unavoidable, the impact on schedule or costs should be built into a revised plan and promulgated.

After installation, systems providing the operating environment for IT equipment should be tested and commissioned.

The programme for testing and commissioning, in accordance with the design specification, should be carefully integrated with the construction work.

The provision, testing and commissioning of the accommodation and operating environment should be correctly demonstrated, documented and recorded.

Documentation should include the following:

– as built drawings;
– testing and commissioning reports;
– operating and maintenance recommendations and procedures.

4.5 Completion

On completion of the project, all appropriate contract documentation should be made available to the client, the building operator and the building maintainer. This will include the following minimum documentation:

a) operation and maintenance literature;
b) as fitted drawings;
c) specification and tender documents;
d) variations and design changes during construction.

The records should also be delivered by the Planning Supervisor to the client as part of the Health and Safety File for the building.

When arranging any contract it is prudent to include within the terms of the contract a period after completion in which the contractor, at no extra cost, is responsible for correcting any defects.

NOTE. Where mechanical and electrical systems are included in the contract a period of 12 months after completion is normally considered adequate. Where a contract only includes building work a period of six months is commonly used for this purpose.

5 Construction

5.1 General

IT equipment of increasing capability and variety is used in most offices, schools, colleges and hospitals, with the majority of the workforce in these environments having access to IT equipment of some sort. A personal computer or terminal installed at each work position is not unusual, and within a short period is likely to become the norm. Many homes have IT equipment and with the increase in teleworking, the distinction between workplace and dwelling place is breaking down. The small office/home office (SOHO) is a large sector of the IT industry's market.

Thus every workplace and the majority of dwellings require the facilities to install and operate IT equipment satisfactorily. In general a building that is suitable for occupation and use by people will also be suitable for the IT equipment used at the work positions. Providing proper provision is made for the operator's physical comfort, i.e. regarding work station layout and visual environment, no additional facilities should be required, other than for bringing power and data cables to the work station.

NOTE 1. See Workplace (Health, Safety and Welfare) Regulations, 1992 [17].

However, where the use of IT equipment is very high, consideration should be given to removing any excess heat either by increased natural ventilation (see BS 5925 for recommendations) or by any suitable form of mechanical ventilation or air conditioning to maintain occupant comfort and productivity and prevent overheating of equipment.

Where the personal computer density is high, professional building designers and building services engineers should be consulted as to whether suitable working conditions can be maintained.

NOTE 2. For working in comfort, the Chartered Institution of Building Service Engineers (CIBSE) Guide Volume A, Section A1 [9] recommends a range from 13 °C for heavy work to 20 °C for sedentary work. The World Health Organization (WHO) recommends 24 °C as the maximum temperature. Beyond this dehydration, heat stress and ultimately heat stroke can occur. Cold temperatures affect dexterity and mobility and may increase physical and visual strain, with added problems for people with muscular pain, arthritis and heart conditions. (Source: London Hazards Centre Factsheet The Daily Hazard No. 47 June 1995 [56].)

Buildings are designed and constructed to have a lifespan of many years. IT systems, even the largest installations, have a comparatively short life. Thus during the life of a building the IT installations within it can be changed many times.

Whilst detailed changes to IT equipment cannot be foreseen, where possible buildings should be designed so as to be flexible in use to facilitate these changes without the need for alterations to the building or its structure. See BS 6266 for recommendations on fire precautions for large mainframe installations.

5.2 Space planning – work station layout

Regulations issued under the Health and Safety at Work Act 1974 [18] govern the layout and use of work stations. The Schedule to the Health and Safety (Display Screen Equipment) Regulations 1992 [19] sets out minimum requirements. Work station layouts and their relationship to the building should be in accordance with BS EN 29241 : Part 1.

NOTE 1. BS EN 29241 : Part 1 gives recommendations for work stations which meet and sometimes exceed the regulations cited above.

NOTE 2. Recommendations for the layout of workstations in schools and colleges are given in Computer Rooms – Scottish Council for Educational Technology [71].

A desk based IT system may take up 20 % to 50 % of the desk surface depending on its intended use. Large screens, e.g. in a CAD system, may occupy the whole of a desk where paper or reference material is not used. A telephone sales point using computing likewise will not need to provide much space other than that required for the workstation equipment (see figure 1).

NOTE 3. See Display Screen Equipment at Work Guidance on regulations [48].

5.3 Space planning – general and dedicated IT rooms

In addition to the work station layouts the planning of office space where IT equipment is used should also take into account the ancillary and peripheral equipment needed for the systems, particularly communications and network electronics.

Where the system specification to be installed is known, full details of the equipment and its requirements should be obtained from the supplier or installer and the space requirements should be planned in detail.

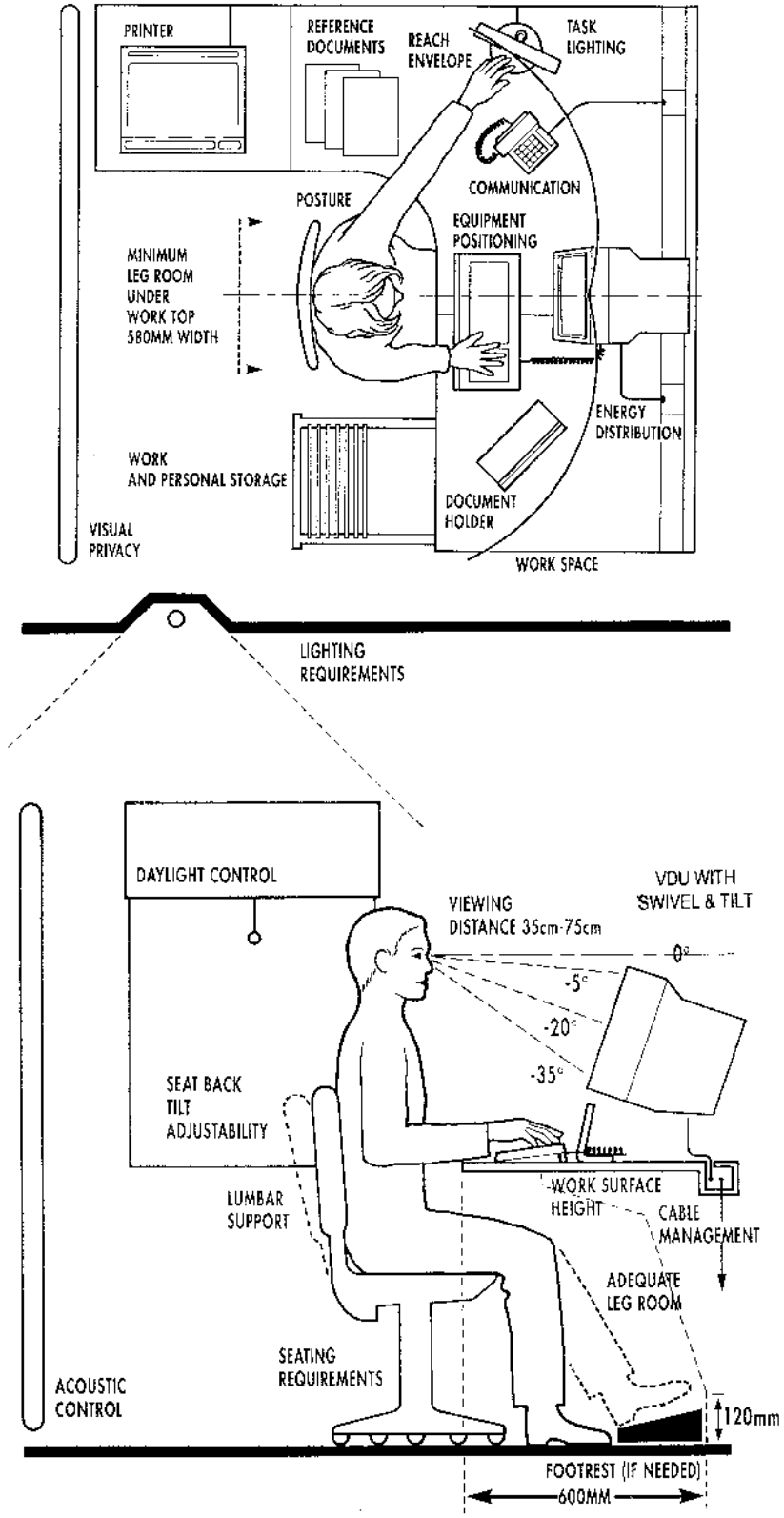
Where the IT system has not yet been decided upon, space allowance for this ancillary and peripheral equipment should be made proportional to the usable area.

NOTE 1. With regard to space allowance, although no precise measurements can be given, it is recommended that such space allowance be made in proportion to the usable area. In modern PC based systems the majority of the peripheral equipment is within the area of the workstations and as little as 1 % of the usable area could be required for other IT and communications equipment.

However if it is envisaged that other intelligent office equipment is to be used, such as copying and facsimile machines and large format printers or plotters, this allowance may need to be increased to 5 %. It should be noted that this allowance does not include the space occupied by the office machinery itself for which, if the details are not known, a further 5 % of the usable space should be allowed.

The areas or rooms set aside for the IT system ancillary and peripheral equipment should be planned using the same criteria set out in **5.8** for dedicated IT rooms.

NOTE 2. Useful guidance on the design of such equipment rooms is given in Applications Manual AM 7: Information Technology and Buildings – CIBSE [4].



Source: VDU Workstations – Keys to Usability – FEI (EEA) [14]

Figure 1. Workstation design

5.4 Power and data cable distribution

Large amounts of cabling are associated with even a single small personal IT installation. Where numbers of such units are installed in the same building, particularly where they are connected in a network, the quantity of such cabling becomes an important factor in the design of the structure as well as being of overriding importance in the layout of the work stations.

The design and installation of cabling within work stations should be in accordance with BS 6396.

The installation of cabling particularly in restricted spaces such as trunking or ducts should be carefully considered as such cabling will need to be moved, removed or replaced from time to time and inspected for functional and safety reasons.

NOTE. Guidance on the structural requirements for cabling within buildings and the various methods of distributing cabled services to work stations and ancillary and peripheral equipment can be found in Applications Manual AM 7: Information Technology and Buildings – CIBSE [4].

5.5 Structural design of buildings

The normal floor loadings as given in BS 6399 : Part 1 are appropriate for the majority of buildings in which IT equipment and associated ancillary storage are to be installed.

However, in some large installations, certain heavy equipment is necessary, e.g. mainframe computers and standby power systems. It may also be necessary in these systems to store data safes and to store and handle large quantities of paper. In these cases the floor loading for the equipment and stores should be checked by a professional structural engineer.

Areas used for installation access for equipment with high point loads should be capable of withstanding floor loading at least equal to that in the area in which the equipment is to be installed. Where point loads are high, load spreading techniques should be used to reduce the loadings. These should be in accordance with the normal limits for the type of building defined in BS 6399 : Part 1, and the problems of maintenance and removal of such equipment should also be considered.

5.6 Surface finishes

Finishes should be smooth and resistant to dust collection. Surfaces beneath raised floors and above suspended ceilings should be sealed with resin or other suitable sealant to aid cleaning and reduce the amount of dust and flaking of building material. See BS 5295 : Part 2.

5.7 Raised access floor

A raised access floor provides an under floor void for the containment of power and data cables, piped services (e.g. cooling water, air conditioning ducting). It may also be used as a plenum for air distribution (see **6.2.2.2**).

An access floor is considered to be essential in accommodation for mainframe computers and ancillary equipment and should provide a void of at least 400 mm high.

NOTE 1. Where heavy power cables run on trays and ducting is required, the void should be suitable to meet any special requirements, e.g. for bending radius.

It is also current practice to provide raised access floors in general office accommodation and dealer rooms where power and data cables are required to work stations. The minimum void should be 150 mm high.

NOTE 2. In refurbishment of existing buildings where the floor to ceiling height is restricted, this might not be possible.

An access floor generally consists of 600 mm $\times$ 600 mm interchangeable load bearing panels supported on a similar grid of adjustable pedestals. Systems required to support heavy loads may be fitted with stringers between pedestals. These will also provide additional lateral stability, but can restrict access.

NOTE 3. Lateral stability can be a problem where panels are missed out under equipment to provide access unless bracing is installed.

The sub floor should provide lateral distribution of concentrated loads. In addition, the concrete sub floor should be designed to cater for the concentrated loads imposed by machines through the raised floor panel and pedestals. The structural engineer needs to know the pedestal grid configuration and the pedestal base size to assess the sub floor load capacity.

Raised access floor systems can be supplied to meet various structural requirements and four grades are currently available:

a) extra heavy grade for heavy computer and ancillary equipment accommodation;

b) heavy grade for general computer and ancillary equipment accommodation;

c) medium grade for office accommodation and dealer rooms;

d) light grade for office accommodation where only light equipment is to be installed and where pedestrian activity is expected to be minimal. This grade is not recommended for major commercial operations.

Access floor installations should be manufactured, tested and installed to meet the specified requirements.

NOTE. Further information is contained in the Access Flooring Association document, MOB PF 2 PS/SPU (March 1992): Platform Floors (Raised Access Floors): Performance Specification [1].

The load bearing characteristics of a concrete sub floor cannot be compared with that of a raised access floor which consists of separately supported panels. These panels only distribute concentrated loads over the area of each panel. The critical design consideration is the concentrated (25 mm^2) load and deflection (max. 2.4 mm over 24 h) of each panel in the system. Panels designed for a specific concentrated load are generally capable of supporting a uniformly distributed load (UDL) much greater than that required for the concrete sub floor.

The design criteria heavy and extra heavy (see items a and b above) require a UDL of 12 kN/m^2 but it is not necessary to provide a sub floor to this rating. See BS 6399 : Part 1.

NOTE. Because of the differing characteristics it is not necessary to provide a sub floor to the UDL rating of the access floor, e.g. the design criteria of a heavy or extra heavy access floor are capable of supporting UDL of 12 kN/m^2, but the sub floor need not be to this capacity.

For recommendations on fire precautions for raised access floors see BS 6266.

5.8 Equipment rooms and dedicated IT rooms

The approach to the design for the building should be similar whatever the size of the equipment room. The primary consideration should be space allocation for equipment. In this calculation the probability of system expansion should be taken into account.

Access to equipment should be provided for maintenance, with passageways in front and behind of the following dimensions:

a) where access is required to the rear, not less than 900 mm wide for a single row of equipment;

b) between two rows of equipment, a minimum of 1350 mm, but manufacturers' installation and maintenance guidelines should also be consulted.

General floor to ceiling heights should be a minimum of 2400 mm, although a height of 2600 mm is preferred.

Passageway heights should be a minimum of 2100 mm.

The shape of equipment rooms should be dictated by the foot-print topology of the equipment to be installed. A rectangular area without obstructions such as structural columns is usually preferred.

Where practical, equipment should be of a consistent construction, so that economic space allocation can be achieved. See BS 5954 for recommendations.

When planning the layout of such areas, equipment should be located in such a way as to avoid short-circuiting any conditioned air supply, e.g. the exhaust outlet of one equipment should not be adjacent to the inlet of another.

Adequate provision should be made to bring cabled and piped services, e.g. power, data and possibly cooling media to the equipment.

For large systems a raised floor is the most convenient way and a floor void of a minimum height of 400 mm, preferably 600 mm, should be provided. If a raised floor is used its structure should allow unrestricted access to the void. For smaller systems alternative methods of cable distribution may be necessary.

NOTE. Guidance on the alternatives is given in Applications Manual AM 7: Information Technology and Buildings — CIBSE [4].

Only services required by the IT equipment should be brought into the equipment room. If it is unavoidable, other pipework should be in the floor void and cables should be as far as possible away from the equipment in order to avoid conflict with air flows, hardware access and other services.

Services related to the room, rather than the equipment, e.g. luminaries and associated cabling, should be at high level either in a ceiling void or surface mounted to a structural ceiling.

Equipment and cabling related to fire detection or protection and other security systems may be installed within a floor void or at high level in the ceiling void or surface mounted. Fire extinguishing systems may require the location of distribution pipework and discharge heads in the ceiling and floor voids in addition to coverage of the occupied spaces. See BS 6266 for recommendations of fire precautions.

Consideration should be given to the installation of a water detection system in the floor void, together with a bunded area in the location of the final connection points for water services to the IT equipment.

Where air distribution provides any necessary cooling of the IT equipment, floor and ceiling voids may be used as supply or return air plenums. The direction of air flow should be arranged to suit the equipment. Where ceiling voids are used as air plenums they should have a minimum size similar to floor voids, that is at least 400 mm of relatively unrestricted clearance.

Finishes in equipment and dedicated IT rooms should be easy to clean and should not produce dust. The use of loose fibre carpets or carpet tiles should be avoided.

Where clean room standards are required for the equipment room, finishes should be in accordance with BS 5295 : Part 2.

Equipment rooms for active power systems supporting IT systems containing standby generating sets, uninterruptible power systems and batteries should be designed and constructed in accordance with the relevant BS Codes of Practice. For further guidance, see BS 6132, BS 6133, BS 7698 : Parts 1 to 6 and BS EN 50091 : Part 1.

Where these BS Codes of Practice do not provide the necessary information, the manufacturer of the power equipment or a professional electrical engineer should be consulted.

Physical access into all equipment rooms should be adequate to allow passage of the equipment to be installed and, where necessary, its packaging. Clearance of at least 40 mm should be allowed over the maximum dimensions for handling (see **5.10**).

All internal surfaces swept by an airflow should be smooth and free from cracks, ledges and cavities. Where the environment in a space is to be controlled, or dust control by ventilation filtration is to be used, the number of corners should be minimized, particularly internal corners. Wherever possible internal corners should be rounded with a minimum radius of 25 mm.

5.9 Suites of rooms for dedicated IT use

In large IT installations, in addition to the rooms for the IT equipment, telecommunications, media storage and other equipment, space is required for staff work areas, various stores and plant rooms. These areas may typically include one or more of the following:

a) staff areas:
   1) engineers' work room;
   2) supervisors' and managers' offices;
   3) work-reception and job-assembly areas;
   4) data preparation areas;
   5) IT room viewing area;
   6) welfare facilities, e.g. catering, toilets, rest rooms etc.;
   7) circulation areas;

b) stores:
   1) magnetic and other media;
   2) secure, ready-to-use, bulk stationery;
   3) engineers' spares, tools and test equipment;

c) plant rooms:
   1) environment control, e.g. air conditioning;
   2) electrical power distribution;
   3) standby power equipment;

d) equipment areas:
   1) IT;
   2) telecommunications, possibly for more than one service provider;
   3) printing;
   4) media loading equipment associated with tape or disk libraries.

The requirements for any particular installation should be assessed from the work to be performed, the management environment and structure and the systems and equipment to be used.

As with any other process the relationship between the rooms should be arranged to suit the sequence of work flow. It should be noted that the actual area occupied by IT equipment may be only a small percentage of the total, and its position within the suite should be determined so as not to interfere with the flow of work, staff and physical items such as paper.

However, certain areas and rooms should be arranged for convenient access to the equipment areas. These might include the engineers' work rooms and stores.

The suite should be laid out so that no access from outside is possible without passing through an appropriate control point. For example the engineers' work room should be on the delivery route for equipment so that inappropriate materials, such as packaging, are not taken into equipment rooms, and personnel should be able to access equipment rooms only through a security control point appropriate to the level of security in use.

Plant rooms, e.g. for power and air conditioning, should be as close as possible to the rooms or areas which they serve. It should be noted that areas other than the IT equipment area may require environmental control and specialist power installations and will therefore require adjacent plant rooms. Some economy in space may be achieved if all such plant areas are combined into one room, but this should be balanced by the requirement that the plant should be near the rooms or areas it serves.

Controlling environmental conditions can be expensive in terms of capital and revenue costs. Therefore any area to be controlled should be limited to that where it is essential for particular equipment and by taking appropriate measures to achieve passive environmental control. For example the location of equipment in a room with a cool aspect will minimize solar heat gain.

Areas with controlled environments should be physically separated from uncontrolled areas, with careful attention being paid to accidental air leakage. Doors between such areas may require air locks if access is frequent, but it is more economic to arrange the suite so that access into controlled areas is infrequent.

The siting of buildings containing suites of rooms for dedicated IT equipment use is constrained by the usual criteria of economics, planning regulations and other legislative restrictions. The construction of the building is also constrained by building regulations.

Account should also be taken of the local environment in terms of possible electromagnetic compatibility (EMC) with radio, radar or similar installations or industrial plant, air pollution, vibration from air, road or rail traffic and shock from heavy industrial plant.

NOTE. Where it is planned to use basements and they are to be staffed, it may be necessary to negotiate with the authorities over special provisions for phased evacuation procedures, otherwise basements are usually required to be evacuated immediately whenever a fire alarm is activated.

5.10 Access

See also **5.9** for access considerations within a suite of rooms for dedicated IT use.

The size of circulation areas in buildings, e.g. the width of corridors, is normally dictated by the requirements for fire escape routes. In the majority of cases such corridors are adequate for moving IT equipment. However in dedicated IT equipment areas it may be necessary to make special arrangements.

With large equipment the access criteria are set by the size and manoeuvrability of the mechanical handling plant, such as trolleys or forklift trucks, used to carry the equipment. Whilst in larger installations it may be necessary to provide permanent large access ways such as double doors and ramps, it is sometimes possible to arrange the building with temporary measures allowing simple restoration such as removable windows or panels.

In all cases, the access routes for the installation should be planned before the work is carried out, and safety measures such as route control implemented.

Where the movement of equipment is frequent, the provision of vision panels in access route doors should be considered.

Where lifts are to be used for moving IT equipment they should have adequate load-bearing capacity and their cars should have adequate dimensions. In a new building this requirement should be included in the design brief, and in an existing building the lift capacity should be checked by a lift specialist or the manufacturer. Further information on lifts is given in BS 5655 : Part 5 and Part 6.

5.11 Physical security

The level of security required for any installation, and the physical measures needed to provide that security, should be assessed at the planning stage. Guidance on the implementation of physical security for installations is found in BS 7799 and BS 8220 : Part 2 (see also clause **12**).

NOTE. See also Applications Manual AM 4: Security Engineering – CIBSE [5].

5.12 Fire precautions

In the early stages of planning, local building control officials, the fire authority and the fire insurers should be consulted about precautions against fire and the provisions of means of escape in case of fire in both the construction and the use of buildings.

A risk assessment should be carried out to establish the appropriate degree of fire protection.
BS 6266 gives guidance on fire protection and prevention and other special precautions necessary for dedicated IT accommodation.

Measures that can be taken by designers to safeguard the lives of employees and the public in office buildings of all types in the event of fire can be found in BS 5588. Recommendations on means of escape for occupants of office buildings are given in BS 5588 : Part 3 and BS 5588 : Part 8 gives recommendations for disabled people.

Recommendations for the planning, design, installation and service of fire detection and alarm systems are given in BS 5839 : Part 1 and Part 6. BS 5839 : Part 6 applies to offices which are contained in the home.

NOTE. BS 5839 is to be revised to take account of forthcoming revisions of EN 54. Ultimately there will be one unified European Standard.

Recommendations for the provision of fire extinguishers are given in BS 5306 : Part 6.

Design principles of fire safety, a comprehensive guide – HMSO [37] provides design professionals with constructive guidance on fire science and the essentials of fire safety to be embodied in buildings.

For dedicated IT rooms it may be necessary to give particular attention to structural integrity, the fire resistance and fire seals for compartments compared to external walls, fire separation of media stores from the IT room, and the properties or characteristics of materials used in construction, e.g. ignition and combustibility, flame propagation, emission of (toxic) fumes once ignited.

The advice of the fire prevention officer should be sought if stationery is to be stored in an air-conditioned area.

6 Environmental conditions

6.1 General

Depending on the environmental needs of the IT equipment, office environments considered suitable for people are generally suitable for most IT installations. See the CIBSE Guide [9], Application Manuals and Technical Memoranda for guidance.

IT equipment should be installed, where possible, in the environment recommended by the manufacturer. Should this not be possible, close liaison with the manufacturer should be maintained in order to assess the possible implications.

The environment required will depend on the design and nature of the equipment, the type of application and the reliability expected of the system.

The size of the room, heat generated by the IT equipment and heat from adjoining areas or outside the building will affect conditions in the room. Condensation should be prevented at all times. Temperature, relative humidity and air-borne dust levels may need to be controlled to suit the most vulnerable pieces of equipment and storage and output media.

Particularly vulnerable equipment, media and printing facilities may need to be located in a separate area away from the IT equipment. An assessment of the operation should determine whether this is deemed to be practical.

6.2 Conditions for an IT room

6.2.1 *Classification of IT rooms*

IT equipment is generally installed in one of three types of location, classified as follows.

a) *Type A, dedicated IT room:* type A is a room specifically designed and built for IT equipment, which will be served by dedicated equipment to provide the required operating conditions for the hardware. Ideally, it will be isolated from any associated office areas and will be constructed to maximize the protection afforded to the equipment.

b) *Type B, air-conditioned office, room, or workspace:* type B is a room designed for intensive use of IT equipment at work stations in which the major factor in design of the environment is the heat loads generated by the IT equipment, where air conditioning is a definite requirement, e.g. dealing rooms and other office environments with extensive IT equipment installations.

c) *Type C, non air-conditioned office, room or workspace:* type C is a room in which IT equipment is used at work stations. The room may be naturally or mechanically ventilated, but the heat loads generated by the IT equipment may be removed by limited cooling without full environment control.

For guidance on environmental needs, staffing and removal of waste heat generated by IT equipment refer to the CIBSE guide Volume A Sections A1, A4, A7 and A8, and Volume B, Sections B1 and B2 [9]. In most cases where waste heat removal is required, a professional building services engineer should be consulted. Equipment manufacturers should be consulted to confirm whether a cleaner environment than that required for a normal office needs to be specified.

6.2.2 *Special recommendations for conditions in IT room type A*

6.2.2.1 *Temperature*

Condensation has a deleterious effect on IT equipment. When the IT equipment is switched off the temperature may be allowed to drop below the lower operating limit specified by the manufacturers provided that:

a) suitable precautions are taken to ensure that the temperature does not fall below the dewpoint;

b) environmental room conditions are brought to the correct levels and stabilized before the IT equipment is switched on again. If the air-conditioning system is switched off during nonworking hours, thermostatically controlled heaters should be installed to maintain the room within the manufacturers' minimum and maximum conditions.

Some types of IT equipment require air supplied at a controlled temperature and/or humidity. Generally, control of moisture content is a critical factor and the maximum rate of change should not exceed 6 % relative humidity in 1 h.

NOTE. In the absence of specific recommendations from suppliers for temperature and relative humidity, the following targets are likely to be generally acceptable: temperature in the range of 21($\pm$3) °C with a maximum rate of change of 3 °C/h, and relative humidity in the range 45 %–55 %.

6.2.2.2 *Air distribution*

The choice of an air-distribution system should be made in consultation with the IT manufacturers and should take into account the height of the IT room and the thermal profile of the equipment within the room.

The installation of all services should be coordinated to ensure the unobstructed flow of air throughout the IT room. Care should be taken to ensure that all redundant services are removed when equipment is changed or removed.

Where perforated floor tiles or grilles are installed, they should be positioned after consultation with the equipment manufacturers, to handle the air flow removing the heat given off by the equipment. Provision of dampered grilles and supply air registers aids the balancing of room air distribution.

NOTE. Other requirements are essential in case of fire.

Ductwork, electrical trunking and other services in the floor and the ceiling voids should be arranged to ensure efficient air movement throughout the IT room (see **5.7**).

One, or possibly a combination, of the following air distribution systems may be suitable.

a) A ceiling-supply system using the ceiling void for the distribution of conditioned air and the floor void for its return. This system is used infrequently due to the high heat rejection loads of the equipment.

b) A floor-supply system using the floor void for the distribution of conditioned air and the ceiling void or the room itself for its return. This system is commonly used at present in IT rooms.

c) A system which supplies or circulates air within the IT space without the use of floor or ceiling voids. This type of system supplies air into the room at one level or location, and draws it out at a different level or location.

d) A displacement ventilation system which supplies fresh air at low level and removes contaminated air at high level so that the air at the normal working level is always fresh.

6.2.2.3 *Fresh air*

Where an IT room is to be occupied by people, fresh air should be provided for the occupants. The total quantity of fresh air should be adequate to ensure that the room has positive pressure (see **6.2.2.8**).

NOTE. Refer to the CIBSE Guide, Volume A, Section A1 [9].

6.2.2.4 *Expansion*

Sufficient room for expansion of the IT installation should be considered in consultation with the user at the design stage. An appropriate number of connections should be made available to the main plant together with access ways for services.

6.2.2.5 *Humidifiers*

Steam humidification should preferably be used, although atomizing humidifiers i.e. ultrasonic and compressed air are suitable. Where atomizing humidifiers are installed, they should be used with demineralized water to prevent the introduction of dust particles into the air stream.

6.2.2.6 *Supply air points*

Where a floor void is used as an integral part of the supply air system, consideration should be given to the avoidance of conflict with any cable management and other services within the floor void, possibly installing protection around the air supply points in the sub floor.

6.2.2.7 *Filtration*

The fresh-air supply should be filtered. Filters should also be installed in recirculating air-handling equipment.

If the equipment requires it, or the air is particularly dusty, two-stage filtration should be installed (see BS EN 779). The condition of filters is critical and consideration should be given to the fitting of condition monitoring equipment across the filter, e.g. manometers, or differential pressure switches.

NOTE 1. Guidance on suitable conditions and methods of testing are found in FS 209E (Class 100,000) [73] and BS 5295. Compliance with less stringent requirements than specified in FS 209E [73] may be appropriate.

NOTE 2. Consideration should be given to the fire resistance of filters.

6.2.2.8 *Air pressure*

To reduce the ingress of dust in conditioned rooms, a positive air pressure should be maintained with respect to adjacent rooms, above normal atmospheric pressure. An air lock at the entrance, that is two sets of doors, is advisable.

NOTE. Consideration should be given to staging the room overpressure, from IT room to associated office areas.

6.2.2.9 *Air purging – fire protection*

It is frequently necessary in IT installations to provide automatic fire suppression systems such as water sprinklers and gas flooding. Where gaseous total flooding or local application extinguishing systems are to be included, whether mechanical or electrical, the air distribution system should have a purging facility included in the design. After the operation of such a flooding system the room should be purged of gas prior to reoccupation. Further information and guidance is given in BS 6266, BS 7273 : Part 1 and Part 2, BS 5306 : Part 4.

6.3 Control of environmental conditions

6.3.1 ***General***

When drawing up the design brief, requirements for the environmental condition should be established, and manufacturers should be consulted about the conditions required for their IT equipment. This should include a pre-installation audit undertaken by the manufacturers or suppliers to confirm the suitability of the proposed environment, in advance of any equipment installation.

The differing environmental needs of individual manufacturer's equipment should be carefully considered and reconciled.

Where heat from IT equipment is used as a basic source in the building, account needs to be taken of the effect on heating generally if the IT equipment is shut down. Consideration should therefore be given to the plant shutdown procedure.

If conditions in an office without environmental controls do not match the required conditions for the IT equipment, then a means of altering or controlling the environment should be incorporated. This may take the form of comfort cooling in which air from the space is cooled and recirculated into the space with or without a component of fresh air, or full air conditioning where air from the space is cooled and fresh air, humidity control and dust control is provided.

A poorly maintained building will have a significantly shortened life. Consideration should be given at the planning stage to the inclusion of a well designed and maintained air conditioning system, which can extend the life of a building.

6.3.2 *Monitoring of environmental conditions*

It is generally advisable that the temperature and humidity in type A rooms should be monitored and recorded and coupled to a device or a system that records the temperature and relative humidity, and sets off an alarm if they go outside specified limits.

Consideration should be given to design of sensing systems that can facilitate:

– automatic call-out of staff in the event of a problem;

– controlled IT system shut-down.

In addition, integrated systems may:

– automatically trigger fire extinguishing systems in the event of fire;

– initiate a shut-down sequence according to detected conditions.

NOTE 1. Further information is given in BS 7629.

The sensors should be sited away from air and moisture intakes and sources of heat, e.g. the IT equipment.

NOTE 2. It is sometimes advisable also to monitor air quality at appropriate intervals at the air inlet.

NOTE 3. Under certain conditions, an option may be practical to monitor air intake and to use only recycled air when incoming air becomes unacceptable. This option requires careful examination of other design considerations to maintain an acceptable operating environment.

6.3.3 *Selection of environmental control equipment*

In uncontrolled environments special account may need to be taken of the effect of the external ambient conditions. In particular, consideration should be given to providing humidification to overcome conditions that can lead to problems caused by static electricity. The rate of change, however, should be slow to avoid significant changes to equipment close to discharge grilles (see **6.7**).

Air-conditioning may be needed to keep the temperature and the moisture content in the IT room within manufacturers' recommended limits and to filter recirculating and fresh air. The air-conditioning plant may be housed in the IT room, free-standing or against a wall, or in a separate plant room. The final choice of plant location should be considered carefully with the user, as this may affect future room changes.

The air-conditioning plant normally requires the following services:

a) pipework connection to remote primary plant, where surplus heat may be extracted. The plant may be a chiller to supply chilled water, an air or water cooled condensing unit to supply refrigerant, a dry cooler or evaporative condenser;

b) mains water supply to and drainage from the humidifier;

c) electricity supply (single or three phase);

d) appropriate space.

To reduce variation in temperature and risk of condensation, air-conditioned rooms of Type A should preferably be windowless. However, in such cases consideration needs to be given to the impact of the absence of windows on people occupying the room.

Doors should be self-closing. Air locks or service tubes should be considered for IT room access points, to reduce dust contamination and maintain the room temperature and humidity levels.

These measures enable an enhanced level of security to be afforded to the room.

6.3.4 *Standby facilities and maintenance of environmental control equipment*

Provision should be made for standby facilities to remove the possibility of breakdown of the plant disrupting IT operations, particularly if continuous operation of the IT equipment is essential. Normally the duplication of vulnerable plant, the installation of multiple air-handling units or the provision of a spare unit(s) suffices. The chosen combination of equipment affects the size of the redundant capacity (see clause **8**).

Consideration should be given to plant maintenance at the design stage, to reduce the impact of a system failure on the IT equipment operation. Appointing a maintenance and commissioning contractor should also be considered at the design stage, as this may impact the design solution.

A suitable maintenance plan should be developed for the plant, considering condition based maintenance, time based maintenance and failure mode. For recommendations on maintenance plans and contracts see clause **13**.

NOTE. Further information can be found in Technical Memorandum TM 17 Maintenance Management for Building Services – CIBSE [10].

6.3.5 *Water shortage*

In the event of a water failure, sufficient capacity to support the condenser circuits and room humidification loads should be stored in a separate tank to maintain the IT equipment environmental conditions.

6.3.6 *Commissioning and testing of air-conditioning plant*

The contract documents for the installation should include a requirement for commissioning and testing of all plant. An assessment should be made as early as possible in the design process to establish a commissioning programme both for completely new installations and for revalidation after subsequent changes. Time to complete the works will be dependent on the size of the installation.

The available cooling capacity should be taken into account when considering changes to the size or installed cooling load of a room. Validation of plant performance should be considered as part of any installation or removal programme.

6.3.7 *Media (magnetic or optical)*

Media should be stored in a separate room within the air-conditioned area (see BS 4783 : Parts 1 to 8). Manufacturers' guidelines should be referred to.

6.3.8 *Stationery*

Stationery requires storage in an area of known and controlled moisture content. If this space is not controlled in accordance with printing requirements then a transient storage area is required to allow the paper to stabilize in accordance with operational requirements before use. Manufacturers' guidelines should be referred to.

6.4 Acoustic

6.4.1 *General*

The need to keep down noise levels should influence the choice of materials for the IT room and its layout.

The room should:

a) protect any occupants from potentially hazardous exposure to noise;

b) maximize the working efficiency and comfort of the users by reducing noise levels generally and specifically by eliminating annoying, disturbing or distracting features of the noise environment.

6.4.2 *Methods to address acoustic conditions*

An acoustically suitable room design depends on careful selection of IT equipment, plant, layout and consideration of the following:

a) absolute levels of noise output;

b) consistency/variability of noise;

c) intermittent noise;

d) regular noise events;

e) impulsive noise events;

f) audio output from equipment (especially multimedia and video conferencing).

Simple screens or barriers are easy to install and can attenuate passage of sound but their impact on acoustic control might be limited. Care is needed to meet any requirements for fire-resistance.

NOTE. Recommendations on reducing noise levels are given in HSE publication Noise at Work, Noise Assessment, Information and Control, Noise Guides 3 to 8 [52]. Also see the CIBSE Guide, Volume B, Section B12 [9].

To minimize direct sound, noisy equipment should be sited away from operators and screens or enclosures around the equipment should be considered.

For reverberant sound, absorption should be provided taking care to avoid materials which shed particles or emit fumes. Particular attention should be paid to ceiling surfaces as these are normally the largest exposed area.

Many new IT systems are now multimedia with sound output and attention should be given to the effect on others working in the area, for example distracting their concentration or affecting their productivity. On such equipment the use of headphones instead of speakers, or sound booths can assist in reducing this problem. However, in such cases precautions should be taken to alert users to the operation of a fire alarm or other audible warnings by the provision of additional non-audible warnings. See BS 5839 Part 1.

6.5 Refrigeration

The air-conditioning system should be capable of cooling the IT equipment in accordance with the manufacturers' recommendations. Its capacity should be capable of expansion if more IT equipment is to be added later.

Because of the high heat-loads produced by larger mainframe computers, some manufacturers may require, in addition to normal air-conditioning, a supply of chilled water pumped directly to the IT room to remove excess heat direct to the cooling plant. The chilled water may be supplied from the main air-conditioning plant or, more generally, from a purpose-built, free-standing unit. A technical specification for the chilled water supply should be obtained from the supplier of the IT equipment where applicable.

Consideration should also be given to the installation of an automatic refrigerant gas detection system. See BS 4434.

6.6 Electromagnetic compatibility (EMC)

6.6.1 *General*

IT equipment that conforms to the requirements of European New Approach directives (indicated by the presence of 'CE' marking of the equipment), is designed for adequate minimum levels of electromagnetic compatibility (EMC). Provided the equipment is installed and operated in accordance with manufacturers' instructions it should not need any further special treatment of the environment unless an unusual location feature exists, e.g. close proximity of a radio transmitter (see **5.9**).

Consideration should be given to controlling the use of communications equipment where, especially with mobile or portable equipment, interference might be a problem.

NOTE. PD 1001 provides guidance on compliance with the EMC Directive [67].

6.6.2 *Older IT equipment*

Where older IT equipment is in use and has known EMC problems, the effects of radiated electromagnetic interference may be reduced by shielding IT equipment and associated cabling and by earthing large metal surfaces within the building. This is often necessary as a safety consideration in equipotential bonding of the facility. Such bonding treatments should be provided in such a way as to avoid introducing other EMC problems.

6.6.3 *Immunity from radiated fields*

Information Technology equipment is in general designed to operate in electromagnetic fields of upto 3.0 V/m over a frequency range of 150 kHz to 1 GHz. It is essential that the equipment manufacturer be consulted if the presence of fields of higher strength are known or suspected. See BS EN 50082-1.

NOTE 1. Additional guidance is planned in the forthcoming publication of EN 55024.

NOTE 2. In some installations close to overhead power lines or underground cables it has been shown that some Cathode Ray Tube equipment conforming to BS EN 50082-1 has exhibited display interference.

6.6.4 *Protection against conducted interference*

New IT equipment meets minimum requirements for immunity against mains-borne noise and is adequately protected against small mains transients and spikes. Where supply difficulties cannot easily or economically be removed, some mains conditioning may be necessary. Provision of an Uninterruptible Power Supply (UPS) or back-up supply often removes the need to guard against any specific EMC problem by ensuring the reliability and high quality of supply levels.

6.6.5 *Protection against mains flicker*

Where multiple equipment shares common local mains supply connection, consideration should be given to the possible short term voltage reductions which may occur due to inrush current at the time of switching on other items sharing that same distribution point. Such mains flicker could cause essential equipment to initiate a reset without warning and the attendant risk of loss of data or service should be taken into account.

6.6.6 *Conducted interference on data lines*

Conducted interference is noise induced into metallic conductors within inter-equipment cabling which may affect the performance of the transmission equipment.

The interference may be reduced by the use of:

a) installation techniques recommended by the suppliers of the transmission equipment and cabling;

b) effective separation of mains electricity and telecommunications cables;

NOTE 1. See BS 6701 or forthcoming EN 50174 when available.

c) filters fitted where the cabling enters the transmission equipment;

d) optical (fibre) cabling.

Consideration may also be given to the control of mobile or portable radio equipment where interference from such equipment may cause a problem.

NOTE 2. Under the EMC Directive [67], cables and cabling accessories are regarded as components performing no direct function and the Directive does not apply to them. There is no requirement, therefore, for manufacturers of such items to attest their conformity.

NOTE 3. For further details see DISC PD 1001 and the Electrical Contractors' Association guidelines, Recommended Cable Separations to achieve Electromagnetic Compatibility (EMC) in Buildings [12]. See also IEE Guidance Note 1 on selection and erection of equipment [55].

6.7 Electro-static discharge

Movement of air and materials such as media, garments of staff all offer potential static electricity generators. In addition, the screen face of visual displays often becomes charged, attracting dust which impairs visual characteristics. IT equipment is usually designed to cope with moderate levels of static discharge but may malfunction if either the protective measures or machine covers are damaged or removed or in the event of higher charges being present.

Static electricity can be an annoyance and a potential hazard to personnel and a source of data loss. The tendency for an installation to be prone to static build up can be relatively easily addressed by the application of simple treatments. The heat produced by most electronic and electrical equipment tends to reduce humidity and thereby decrease the likelihood of natural dissipation of static electricity. Humidifying plant should therefore be fitted where this is a particular problem and air conditioning layouts should be chosen with care.

Floor coverings or approach mats which contain conducting fibres are also recommended where choice can be exercised. If existing floor covering is unsuitable and cannot be removed, anti-static mats can provide limited protection for small IT systems or terminals. It may be necessary to connect extraneous fittings such as glass doors and metal handles to an earth reference point.

For further guidance on the control of static electricity see BS 5958 : Parts 1 and 2 and BS EN 100015 : Parts 1 to 4.

7 Visual environment

7.1 General lighting

The safe and efficient execution of any task in which the visual sense is used is dependent on the lighting. The visual environment is important to the comfort and long term health of the occupants (see figure 1).

NOTE 1. Recommendations for minimum standards to ensure health and safety of workplaces are contained in The Workplace (Health, Safety and Welfare) Regulations, 1992 [17] and Lighting at Work (HS(G)38) [44].

Guidance on The Workplace Regulations can be found in the Display Screen Equipment at Work Guidance on regulations [48]. Detailed guidance on the provision of a visual environment for efficient task performance is given in Code for Interior Lighting – CIBSE [6].

Light for the performance of any task can be provided by natural or artificial light, although studies have shown that most tasks are more efficiently and comfortably carried out using natural light, i.e. daylight.

The use of fenestration for increasing natural light should always be balanced with the increased heat losses and solar heat gains through the windows and the possible decrease in physical security engendered by increased window sizes. Recommendations for the daylighting design are given in BS 8206 : Part 2.

NOTE 2. See also Applications Manual AM 2: Window Design – CIBSE [7].

The design of lighting in IT installation is a specialized operation, and professional lighting engineers should be consulted where necessary.

7.2 Display screen equipment

The operation of IT equipment normally entails the use of visual display units (VDUs) sometimes known as display screen equipment, (DSE). To maintain comfort and efficiency users require very specific associated lighting conditions.

NOTE 1. The regulation governing the use of such equipment, Health and Safety (Display Screen Equipment) Regulations 1992 [19], includes in its schedule specific requirements concerning the visual environment in which VDU or DSE can be used. Lighting at Work (HS(G)38) [44] sets out minimum standards and Lighting Guide LG3: Areas for Visual Display Terminals – CIBSE [8] gives specific and detailed guidance on the design of the visual environment using artificial light.

As noted in **7.1** daylighting is the preferred method of providing a comfortable and efficient working environment. However designing a suitable environment using daylight in which VDU or DSE are to be used is not a straightforward operation because of the need to control reflections and glare.

NOTE 2. Some guidance on design can be found in Building Research Establishment Guidelines, Daylighting requirements for display-screen equipment (IP14/93) [2] and Daylighting design for display-screen equipment (IP10/95) [3].

Applications in which VDU or DSE form part of the workstation equipment should conform to the requirements of BS EN 29241 : Part 3.

7.3 Emergency and standby lighting

Most working environments are required by the Fire Authorities to have emergency lighting to provide adequate lighting in case of fire or other emergency. In some installations it may also be necessary to provide standby lighting so that work can continue where the main power supply fails. Relevant requirements can be found in BS 5266 : Part 1, but a professional lighting engineer should be consulted.

7.4 Lighting for maintenance

For many maintenance tasks on IT hardware exceptionally good lighting is required.

Some equipment is complex in its physical layout and has components that are difficult to see. It often carries a high risk that errors have unusually serious consequences.

A design-maintained illuminance on the task of 1500 lx or more should be provided. This can usually only be achieved by direct illumination from light sources close to the task.

Areas such as maintenance workshops associated with IT installations should be provided with portable task lights to provide the required high levels of illumination. Where maintenance tasks are to be carried out on the IT installation in situ, similar lights should be provided, along with suitable power outlets enabling the portable lights to be used. Where a large IT installation is normally unmanned and housed in a room with a low level of illumination, the provision of lighting for maintenance is particularly important.

NOTE. Where portable lighting is used, care should be taken to ensure it is robust and safe in operation, cool to work by, and the risk of operators tripping over it is minimized.

8 Electric power

8.1 Electricity power supply

8.1.1 *General requirements*

The minimum quality of supply that an individual location receives is mandated under the Electricity Supply Regulations [20]. However, recent European harmonization has changed the levels of performance which customers of the supply authority may expect.

The Electricity Supply Regulations SI 1988 No. 1057 [20] and its Amendment (No 2) SI 1994 No. 3021 [21] state:

'Unless otherwise agreed the frequency declared will be 50 Hz and the voltage declared for a low voltage supply should be 230 V between the phase and neutral conductors at the supply terminals.

The permitted variations are:

a) 1 % above or below the declared frequency;

b) in the case of a low voltage supply 10 % above and 6 % below the declared voltage at the declared frequency.'

NOTE 1. As and from 1st January 2003 the variations in item b above change to 10 %. See BS 7697.

NOTE 2. The tolerances do not include the 4 % voltage drop allowed within the internal customers' installation wiring (see BS 7671).

NOTE 3. An electricity supply taken directly from a standby generator may not be able to conform to these tolerances.

The UK Health and Safety at Work etc. Act [18] and the Electricity at Work Regulations (EAWR) [22] require installations and equipment to be maintained, inspected and tested periodically.

For this reason, it should be possible to be able to isolate individual equipment supplies so as to minimize disruption to other parts of the system. Service socket outlets which are separately fed from the power distribution units (PDU's) for IT equipment should also be provided to avoid either disruption or interference from ancillary equipment such as vacuum cleaners or test equipment.

NOTE 4. Access for servicing should also be considered. See **5.10**.

8.1.2 *Emergency power off (EPO)*

The electrical installations should be in accordance with BS 7671, which applies to electrical installations in buildings generally, including installation of IT equipment.

EPO controls in IT rooms generally shut down all equipment, although these are not requirements of BS 7671.

Their use should be considered against the potential loss of business associated with the sudden shut down of all IT equipment and the false reassurance given that all of the electrical supplies to the room are isolated.

Where EPO controls are used, consideration should be given to avoiding accidental operation.

EPOs are required in certain cases to comply with The Supply of Machinery (Safety) Regulations [42].

Educational establishments have specific requirements for EPOs. See BS 4163.

8.1.3 *Potential impact of supply disturbances and interference*

The mains electricity supply is a convenient and reliable source of power. The voltage and frequency of the supply are controlled by the Regional Electricity Companies and Generating Companies. However, certain disturbances which do not affect most other forms of equipment may be a hazard to IT equipment.

Mains-borne interference can consist of:

– high-frequency noise on the mains (spikes or transients);

– departures from the specified voltage limits (sags or surges);

– continuous interference (narrow or broadband, CW or modulated);

– harmonic distortion which can be created by the customers' electrical equipment as well as the electricity supply network or a third party.

NOTE 1. For further information, see G5/3 – Electricity Association [11].

All the disturbances mentioned above may affect mains supplies from time to time.

The IT equipment supplier should be contacted and asked to confirm that the equipment being offered will perform satisfactorily in the presence of such disturbances.

IT equipment forms a special class of electrical equipment for the following important reasons:

a) IT equipment may lose a portion of its stored data memory if the mains supply is interrupted for even a short period;

b) the sensitive micro-electronics within the IT equipment can be affected by high voltage pulses (spikes);

c) disk drive memory units may fail if the supply frequency rises or falls beyond certain narrow limits.

If the interference is from sources within the building, power for the IT installation should be taken directly from the point of supply to the building via an electrically separate circuit to that which supplies the source of the interference. If it is from sources outside as well as within the building, one of the following should be employed to reduce it. For EMC considerations see **6.6**.

1) *Motor alternator.* Motor alternators provide good attenuation for all kinds of mains-borne interference, but are expensive to run, need maintenance and special accommodation. The use of such machines has almost completely ceased except where non-standard operating frequencies are required, e.g. land based naval establishments using equipment common to sea-borne systems such as 440 V, 220 V or 110 V, 60 Hz supplies.

NOTE 2. See Defence standard DEF STAN 615 (Part 4), Issue 14 [57].

2) *Mains filter*. Electrical passive mains filters designed primarily to attenuate high-frequencies are normally incorporated within IT equipment. Because their use may give rise to high levels of cumulative earth-leakage current, maintenance of the integrity of protective earthing conductors is important for safety (see **8.2**).

NOTE 3. The Electricity at Work Regulations (EAWR) 1989 [22] apply here.

3) *Constant voltage transformer (CVT)*. Constant-voltage transformers reduce long-term departures from specified voltage limits, thus overcoming difficulties associated with sags or surges. Some kinds are also effective against spikes and transients. Their cost is moderate and they generally do not need maintenance.

If a constant-voltage transformer is installed, it should be capable of regulating the maximum power that the IT installation requires. Since the load current of most IT equipment is non-sinusoidal, the device may need to be sized to suit the predominant characteristic of the load in order to ensure no overheating of the CVT. In practice, IT equipment has excellent hold up characteristics and only where the supply authority cannot provide a remedy to voltage reductions outside the nominal range should a CVT be necessary.

4) *Isolation transformer*. Isolation transformers, which are special transformers with shielded windings, reduce the effect of high-frequency noise. They provide good attenuation of noise common to both live and neutral connections (common mode), but poor attenuation of differential mode noise being a voltage which is in addition to the supply voltage. Their cost is moderate and they do not need maintenance.

NOTE 4. The term 'isolation transformer' is more commonly a recognition of electrical isolation of output from input and not all such devices are fitted with effective electrostatic or magnetic shielding. The devices are seldom used in modern IT applications. However, if a requirement exists simply to eliminate common mode problems, then this can be an effective solution.

5) *Other power supplies*. Certain IT equipment may require power at frequencies other than the normal mains frequency of 50 Hz. This may be provided from either a rotary converter (a form of motor-alternator set) or a static converter (similar to a UPS). The manufacturer should be asked to advise on the size of the electrical converter and its environmental requirements.

8.1.4 *Energy conservation*

Most electricity is generated from non-renewable resources. It should be borne in mind that equipment providing environmental conditioning may require up to three times the power of the IT equipment in the user environment.

Where a choice of equipment is possible, particularly in new applications or installations, preference should be given to equipment making efficient use of energy resources and which offers automatic close down or standby modes which reduce power consumption to negligible proportions while still maintaining appropriate conditions when not being used.

8.2 Earthing and protection

8.2.1 *Effective earthing*

Guidance on earthing is given in BS 6651, BS 6701, BS 7430 and BS 7671. The following information draws attention to particular issues associated with IT installation.

Equipotential bonding which is effective at the mains supply frequency should be maintained throughout the installation.

Design, installation or layout constraints may result in earthing which is not adequate to ensure error free operation in all circumstances, particularly when faults produce differences in actual earth potential between zones which are normally equipotential. Even small differences in voltage at two ends of earthed conductors in a given interface or signal cable can have dramatic operational and safety implications.

Whenever long interface cables cannot be avoided, consideration should be given to the danger which arises from leaving one equipotential earthing zone for another, for example from one IT room to another. Wherever possible such cables should be avoided; a useful alternative is based on optical techniques.

NOTE 1. See ECMA 97 [13].

In general, larger cross-sections of conductor are used for protection purposes where the possibility of high earth fault currents exists. For this reason, equipment operating as a system should be connected to a single earthing point in the machine room, (usually the power distribution unit (PDU)). Substantial protective earth connections from power distribution units back to the building incoming earth should be made. This method provides the best solution for the related problems which can arise from the use of electronic business and IT equipment.

Class 1 equipment within IT systems should be earthed to provide not only protection against electric shock but also a reference conductor. IT equipment may have a dedicated earth back to the source of the building. This type of earthing conductor avoids contamination from the rest of the building.

The performance of the mains earth supplied by the local electricity authority is often taken as the reference conductor but if it is not adequate for the IT installation then appropriate measures should be taken to improve it. Components of distribution or IT equipment should be earthed in accordance with the manufacturers' requirements. Local regulations may require that the IT equipment earth connection be insulated from any reference conductor.

NOTE 2. A reference conductor is often referred to as 'zero volt' or 'no volt'.

BS 7671 gives methods of providing protection in systems with high standing leakage currents.

8.2.2 *Residual-current devices (RCDs)*

In general, a correctly specified, located and maintained RCD should be used to protect the user of desk top equipment from almost all the possible faults which can occur which could give rise to an electrical shock hazard.

It is essential that the equipment manufacturers are consulted if residual-current devices are to be used, as tripping caused by earth leakage currents at switch-on is common where high standing earth leakage currents are produced by IT equipment. Older types of RCDs may fail to operate at all in the presence of DC content from the load.

NOTE. This occurs with some input circuit faults.

8.2.3 *Safety of desk and screen systems*

Office furniture, screens and desks containing cabling facilities or mains outlet sockets should conform to BS 6396.

Installation of a permanently connected RCD device should be considered in the supply for desk systems containing mains outlet sockets where the cumulative earth leakage can be unexpectedly high. This is particularly important where there is a likelihood of desks being rearranged to suit a change in office environment.

Electrical and data cables should only be disconnected and reconnected by a competent person. Prior to reconnection a competent person should test for polarity of the socket, output and the system to ensure safe operation.

8.3 Protection of power supply

8.3.1 *General*

The loss of power momentarily or otherwise can have a disastrous effect on IT equipment. Losses can occur either by supply or equipment failures, internally or externally, or by human error. The element of human error can be significantly reduced if adequate attention is paid to simplicity and clarity of operation during the design stage. It should be remembered that equipment may be operated infrequently therefore the logic of the operation and the clarity of labelling are of prime importance. See BS 7671 for information on labelling.

The protection against equipment failure or loss of mains power supply can be improved by the installation of a standby power supply or UPS or both (see **8.3.3** and **8.3.4**).

The standby power supply should be capable of supplying ancillary equipment such as air-conditioning and lighting as well as the IT equipment.

Full review of the load characteristics (particularly the harmonics of IT equipment and UPS systems) should be made to ensure the correct selection of the standby power systems.

8.3.2 *Changeover*

Changeover from the mains to the standby supply normally causes a short supply interruption which can be between 15 s and 30 s. This affects IT equipment but the short break does not significantly affect other supported loads such as lighting and air-conditioning. In order to avoid a break in supply to the IT equipment an on-line UPS should be used (see **8.3.4**).

Changeover on the loss of the mains supply can be manually activated but is usually made automatically by the selection of appropriate control systems on the standby supply equipment. This affects IT equipment, lighting, air conditioning and electrical equipment, but the latter three are restored as soon as an alternative supply is connected.

In the case of IT equipment which has not been backed up or subjected to an orderly shut-down, unstored data is lost and upon restoration of supply the IT equipment experiences start up problems and delays before full IT facilities are available. If an on-line UPS is not used, manual mode is preferable as the changeover can be coordinated with a period when the IT equipment can be switched off. A competent person should perform the manual changeover. Adequate written instructions should be provided beside the changeover switch.

8.3.3 *Standby generator*

Where a standby generator is to be installed, provision should be made for handling and storage of fuel, removal of exhaust fumes, removal of heat from the radiator or heat exchanger and access for regular maintenance and testing under load. Some means of damping vibration and reducing noise may also be necessary.

8.3.4 *Uninterruptible power supplies (UPS)*

8.3.4.1 *General*

UPS equipment is designed to support and protect the IT installation from mains electricity supply failure and can offer protection from interference carried by the electricity supply cables. Its ability to protect the installations is always limited by time and this time depends on the installed battery capacity and the level of charge in the battery at the time of mains electricity failure. Some rotary machines, although old, are still providing UPS facilities.

UPS equipment may be expensive to run and may need considerable maintenance and special accommodation. Many UPS devices can be remotely controlled and managed and this should be borne in mind where local fire regulations require the availability of a true power off situation, i.e. ensuring a means for absolute powering down is protected but available.

A UPS facility can be provided by a static equipment or rotating machinery or a combination of both.

NOTE. BS EN 50091 : Part 1 gives information on safety requirements for UPS equipment.

8.3.4.2 *UPS operation*

UPS equipment provides power indirectly to the IT equipment by rectifying and inverting the mains supply. If the mains supply fails, a supply is generated from the internal battery until the standby supply is switched on-line manually or automatically or the autonomy of the battery is reached, whilst allowing for data to be backed-up or dumped and the orderly shut-down of associated equipment.

Users of UPS devices should be aware that the configuration or mode of operation and the battery capacity and state of charge determine the time for which battery sourced power remains available thus affecting the degree of protection actually achieved.

UPS equipment can be used in the home, office or factory; a competent electrical specialist should be consulted as to what device would best suit operators, their location and their equipment.

8.3.4.3 *UPS configurations*

The following examples indicate the types of equipment available:

a) *off-line operation* means that when the power fails, the UPS will switch in and generate a supply equivalent to mains using the battery supply. The hold-up time of the equipment being supplied is critical to achieving no-break operation. UPS devices which operate in this mode may be physically smaller than their on-line counterparts as they are not always continuously rated. These devices are not recommended for older equipment which tends to have degrading hold-up performance due to component ageing;

b) *on-line operation* means that the load equipment is constantly fed from the supply generated by the battery source and the battery charger continuously powered. This type tends to be chosen for more critical applications where ordered shut-down on power failure is the preferred option and needs to be continuously rated. Most on-line types can switch automatically to by-pass mode and connect the load directly to the incoming mains if the UPS fails;

c) *by-pass-operation* may be manually selected but is more commonly automatically disabled when the mains power into the UPS has failed. An on-line UPS with by-pass is always providing the power to the load equipment, but the operation of the by-pass means that the power is supplied from the incoming mains until the supply fails or falls to a predetermined voltage level;

d) *line interactive* operation allows the equipment to be powered from the incoming mains to the UPS but because its battery sourced inverter is active, it can boost sagging mains supplies on demand at a predetermined threshold voltage or provide full take-over. This type is very energy efficient and provides the optimum compromise in terms of fast changeover for low running costs. Many client-server configurations of computing equipment use this type for support of the host processor;

NOTE 1. Although not strictly a UPS configuration, when battery-powered portable IT equipment (e.g. a laptop PC) is operated whilst its charger unit is connected to the mains, it is behaving similarly to line interactive UPS systems.

e) *programmable and remotely controllable* UPSs are now available which can be managed via communications interfaces; their battery state of charge, performance and output characteristics can be monitored and a large number of UPSs managed from a single point;

f) *back-up supplies* are increasingly being fitted within the equipment itself. Where this is the case, staff may need training in routines and methods for emergency shut-down. In addition, the maintenance and access to equipment which remains live when the mains supply is removed may need additional safety precautions adding, e.g. cabinet locks and written procedures.

NOTE 2. Large battery installations, whether integral or external components of a UPS system, require properly ventilated locations which should never be shared with data storage media or libraries. See BS 6132 and BS 6133.

8.4 Lightning

NOTE. Additional information on protecting a building against lightning is given in BS 6651.

8.4.1 ***Risks***

In the UK, severe lightning strikes as direct hits are comparatively rare. The most common cause of damage in IT installations is from differences in potential of physically connected equipment caused by the unequal rise in earth potential and resulting from a lightning strike to ground in close proximity to one installation but further from the other. These large potential differences can appear across the input stages of electronic equipment with a much lower rating, causing damage. Capacitive coupling between the ground and insulated cables can produce similar potential rises. In addition, inductive coupling of ground currents can cause large currents to flow in any type of conducting path.

8.4.2 *Protection of cables*

Power and signal lines including fibre-optics in metallic protection may need protection against lightning-induced surges and rises in earth potential. Where this is the case, voltage limiting devices may need to be employed together with disconnection or protective devices such as barrier boxes.

Where possible, overhead cables between buildings should be avoided and fibre optic technology utilized. Separation of different types (defined by use) of cables entering the building will significantly reduce coupling effects. BS 6651 gives general guidance on the protection of power and data cables.

NOTE. See ECMA 97 [13] for general information on protection of Local Area Networks, whose principles may be adapted to other cabling schemes and types.

8.4.3 *Protection of installations*

Where no other practical solution is available it may be necessary to increase equipotential bonding at the most susceptible parts of an installation. In most cases this helps to reduce damage rather than eliminate it. This method is commonly implemented as earth meshing in the construction of telecommunication centres.

When meshing protective earths, care should be taken to reduce the inductance of all earth links and if possible to optimize capacitive coupling to reduce potential damage from lightning.

Where protection against lightning is concerned, DC bonding is only part of the solution. The high frequency content of any sudden voltage pulse, such as that produced by lightning, requires bonding methods and paths which are of low impedance at those frequencies. BS 6651 gives guidance on the design of systems to protect installations from lightning.

9 Cabling

9.1 General

Within the IT environment the installation and maintenance of all types of cabling from power to data and from copper to fibre represents a significant investment and as such should be allocated adequate time and resource at the planning and design stage.

The use of zero halogen and low smoke cables should be considered as they offer life safety benefits in the event of a fire.

9.2 Guidance

For guidance on the planning and installation of dedicated cabling systems, reference should be made to BS 6701 and/or manufacturers' recommendations.

NOTE. A standard (EN 50174) is currently being prepared by CENELEC. It is proposed that this standard will detail the operational and environmental considerations in the planning stage and will also define installation and acceptance testing practices enabling the agreement of a quality plan used to demonstrate conformance with installation specifications. It is targeted at dedicated and generic systems utilizing both copper and optical fibre.

9.3 Cautionary considerations

Within the building or campus it is reasonable to expect the installation of many different cabling systems such as:

a) fire;

b) security;

c) building management systems;

d) power;

e) lighting;

f) telephone;

g) data (covering all types of office automation and communication).

Consideration should be given to the interaction of such systems and the relevance of segregation or integration (structured cabling systems).

The requirements and solutions will be influenced by the environment, i.e. whether the installation is a:

a) purpose built IT room;

b) dedicated IT intensive office, such as dealer rooms, IT teaching establishments or modern design office;

c) non-dedicated or specifically designed office;

d) new design or refurbishment.

9.4 Potential problems

9.4.1 *General*

Within the dedicated IT room or IT area particular care should be given to the following:

a) floor construction (see **9.4.2**);

b) cable joints (see **9.4.3**);

c) cable characteristics (see **9.4.4**);

d) cable routes (see **9.4.5**);

e) connections between buildings (see **9.4.6**);

f) redundancy of cables (see **9.4.7**);

g) power supply cables (see **9.4.8**);

h) electromagnetic compatibility (see **9.4.9**);

i) cable entry and exit points (see **9.4.10**).

9.4.2 *Floor construction*

Consideration should be given to the construction of the structural floor.

Whilst it is desirable to lay the cable(s) in or on cable trunking or tray at some point in the installation, either by design or accident the cable(s) may leave the protection of this cable trunking or tray and should be protected from damage by uneven floor surfaces, sharp projecting stones or loose fragments.

9.4.3 *Cable joints*

Where cable joints within cables have to be used in a route, consideration should be given to:

a) their location and robustness to facilitate ease of access for inspection and the prevention of damage in procurement of other works;

b) the ingress of water into such joints due to flooding;

c) the installation of electrical power cables without joints, including all connections made in the equipment, approved switchgear or distribution equipment especially in concealed areas such as under floors or in ceiling voids;

d) where it is essential that cable joints are used, the maintenance of documentation relating to location or type.

9.4.4 *Cable characteristics*

Cable characteristics for each individual cable should be maintained within an installation and the following situations should be avoided:

a) cables being compressed by the weight of other cable being laid on top of existing cables, that are laid in cable trunking or on cable tray;

b) lateral tension or tension on vertically run cables due to inadequate clipping and support being applied to the cables either during the installation or upon completion of the installation;

c) the bending radius of cable being less than the characteristics specified for the individual cable or the kinking of the cable during installation.

9.4.5 *Cable routes*

In the planning of cable routes, consideration should be given to the proximity or operation of other services such as power and data cables, air-conditioning, piped services (sprinkler and chilled water), fire or security. All of these services may be hindered by or may hinder future installations or modifications.

9.4.6 *Connections between buildings*

Aerial installations are subject to all aspects of mechanical stress or damage. Therefore, where possible, cables between buildings should be installed below ground in a manner that facilitates both installation and removal.

9.4.7 *Redundancy of cables*

During the planning of new cable installations consideration should be given to the future removal of all cables. It is normal within the operational environment to continuously upgrade and modify the IT systems. It is very rare that the original cable requirements would completely match the modified system and it is essential that all obsolete cables are removed at the earliest opportunity.

Where new and old equipment is operated in tandem to facilitate a change-over, all old equipment and cables should be removed immediately following decommissioning. Failure to do so will eventually lead to excessive congestion and a significant risk of impact on associated services.

The removal of obsolete cables from a poorly designed, refurbished or upgraded installation may have an operational impact, particularly where the cables are in close proximity to operational services. Potential areas of risk are as follows:

a) damage to cable insulation resulting from friction between cables when being pulled out;

b) the possibility of other cables becoming entangled and the termination of such cables or joints being disconnected;

c) poor identification: a practice often adopted when removing cables is to pull the cable to identify it before cutting off the end or cutting it into short sections to facilitate removal. It is possible within an overcrowded, very compact or tangled installation for adjacent cables to move at the same time as the target cables resulting in incorrect cable identification and cutting.

9.4.8 *Power supply cables*

Power supply cables are normally large in cross-sectional area especially main or sub main cables, where the bending radius can be large. They are normally heavy and special arrangements may be required when installing. Strict adherence to the bending radii, support and fixing centres is essential.

9.4.9 *Electromagnetic compatibility (EMC) considerations of cables*

When planning the installation of a new data cable to be bunched with other data cables, consideration whether the cable may be suitable for the IT equipment to which it is connected but have an adverse effect on existing equipment due to EMC should be made. Cabling should be compatible with the equipment to which it is connected, with reference to manufacturers' instructions. Otherwise EMC compliance of the equipment will be invalidated (see **6.6**). See DISC PD 1001.

9.4.10 *Cable entry and exit points*

Where cables rise vertically from the floor to their point of connection with equipment, consideration should be given to supporting the cable to prevent any vertical strain on the connections and subsequent risk of disconnection, arcing or overheating.

Where cables pass through fire compartments, integrity should be maintained by effective fire-stopping. See BS 7671.

10 Legislation

10.1 Workplace legislation

In the IT environment, health and safety legislation predominates in various forms. Legislation concerns workplaces in terms of the following:

a) construction:
   1) design;
   2) fabrication;
   3) erection;
   4) maintenance;
   5) cleaning;

b) ergonomics;

c) environment.

It covers on-going conditions and suitability for the work force, not only when premises are completed but also during the construction phase. Working conditions should be suitable for the task in hand and should not impose unreasonable risks on those involved. This entails providing safe situations in which to perform tasks, including safe access to the workplace. Materials should be considered for suitability at the time and location of their use and subsequently. Risk assessments may need to be undertaken. Addressing these issues starts at the design concept stage, progressively being considered as the project plan is developed, and communicated to those who have a need to know (see clause **4**).

Primary legislation is the Health and Safety at Work Act 1974 [18] which sets objectives and identifies duty holders as being employers, employees and self-employed persons. Within that framework particular requirements have been expanded upon in regulations.

NOTE. 'Workplace' is defined as premises or part of premises which are not domestic premises and are made available to any person as a place of work, and includes:

i) any place within the premises to which such person has access while at work;

ii) any room, lobby, corridor, staircase, road or other place used as a means of access to or egress from the workplace or where facilities are provided for use in connection with the workplace other than a public road.

10.2 Workplace regulations

10.2.1 *European Union Directives*

Regulations additionally embrace European Union Directives taken into UK law. Those primarily of concern in the context of accommodation and environment of IT equipment are given in table 1.

Some matters addressed are beyond the scope of United Kingdom building regulations and it is important therefore that designers of buildings are aware of the requirements of all the Regulations.

10.2.2 *Principal workplace requirements*

The principal requirements addressed by the Workplace (Health, Safety and Welfare) Regulations [17] are given in table 2.

NOTE 1. The requirement for natural light in the Workplace (Health, Safety and Welfare) Regulations 8(2) [17] is qualified by 'so far as is reasonably practicable' and the HSE have stated they do not regard it as necessarily affecting building design; (paragraphs 63 and 64 of the HSE Approved Code of Practice [46] provide guidance).

NOTE 2. Other requirements concerning the constructed workplace may still remain in the Offices, Shops and Railway Premises Act 1963 [27] and in the Factories Act 1961 [28].

10.2.3 *Construction (design and management) regulations*

The Construction (Design and Management) Regulations [16] set out the duties of the owner and the designers in the construction or modification of the IT accommodation. This requires the implementation of the following before any project commences:

a) appointment by client of a competent Planning Supervisor;

b) allocation of adequate resources for the project;

c) appointment by client of a competent Principal Contractor;

d) production of a Health and Safety Plan;

e) upon completion, giving the client the project Health and Safety File.

Table 1. European Union Directives

Directive	UK implementing law	UK guidance on law	Notes
1. Framework Directive on minimum requirements for safety and health for the workplace (89/391/EEC) [58]	The Management of Health and Safety at Work Regulations 1992 (SI 1992 No 2051) [23]	HSE Publication Management of Health and Safety at Work [45]	Directive sets out broad general duties to ensure health and safety in virtually all workplaces. Individual directives develop those aims.
2. Workplace Directive (89/654/EEC) [59]	The Workplace (Health, Safety and Welfare) Regulations 1992 (SI 1992 No 3004) [17]	HSE Publication Workplace Health, Safety and Welfare Approved Code of Practice [46]	First individual directive, concerned with minimum requirements for safety and health at workplace.
3. Safety Signs Directive (92/58/EEC) [60]	The Health and Safety (Safety Signs and Signals) Regulations 1996 (SI 1996 No 341) [24]	HSE Publication Safety Signs and Signals Guidance on Regulations [53]	Concerned with the provision of safety signs whenever there is a hazard that cannot be avoided or adequately reduced by alternative methods.
4. Manual Handling of Loads Directive (90/269/EEC) [61]	The Manual Handling Operations Regulations 1992 (SI 1992 No 2793) [25]	HSE Publication Manual Handling Guidance on Regulations [47]	Concerned with the minimum health and safety requirement for the manual handling of loads where there is a risk particularly of back injury to workers.
5. Display Screens Directive (90/270/EEC) [62]	The Health and Safety (Display Screen Equipment) Regulations 1992 (SI 1992 No 2792) [19]	HSE Publication Display Screen Equipment at Work Guidance on regulations [48]	Concerned with minimum safety and health requirements for work with display screen equipment.
6. Temporary and Mobile Construction Sites Directive (92/57/EEC) [63]	The Construction (Design and Management) Regulations 1994 (SI 1994 No 3140) [16] The Construction (Health, Safety and Welfare) Regulations (SI 1996 No 1592) [41]	HSE Publication Managing Construction for Health and Safety Approved Code of Practice [49] HSE Publication A guide to the Construction (Health, Safety and Welfare) Regulations 1996 [54]	Concerned with managing project health and safety aspects in design and construction phase.
7. The minimum safety and health requirements for the use of work equipment by workers at work (89/655/EEC) [64]	The Provision and Use of Work Equipment Regulations (SI 1992 No 2932) [26]	HSE Publication Work Equipment Guidance on Regulations [50]	Concerned with the provision and use of any equipment used for work.
8. —	The Electricity at Work Regulations 1989 (SI 1989 No 635) [22]	HSE Publication Memorandum of Guidance on the Electricity at Work Regulations 1989 [51]	Concerned with the safety of electrical installations and their use and maintenance.

Table 1. European Union Directives (*concluded*)			
Directive	**UK implementing law**	**UK guidance on law**	**Notes**
9. 89/391/EEC [65] 89/654/EEC [66]	The Workplace (Fire Precautions) Regulations [38][1)]	[HSE guidance not available]	To be administered by the Fire Authorities. Public consultation document. [Subject to successful consultation, expected publication 1997].
10. EMC Directive (92/31/EEC) [67] and (93/68/EEC) [68]	The Electromagnetic Compatibility Regulations (SI 1992 No. 2372) [40]	[HSE guidance not available]	EC Guidelines on the application of the Directives are not available.
11. The procurement procedures of entities operating in the water energy, transport and telecommunications sectors (89/951/EEC) [69]	The UK Utilities Supply and Works (Contracts) Regulations 1992 (SI 1992 No 3279) [43]	[HSE guidance not available]	Concerned with the procedures for tendering, applies to UK utilities and may also be extended to encompass other large organizations.
12. The Machinery Directive (89/392/EEC) [70]	The Supply of Machinery (Safety) Regulations SI 1992 No 3073 [42]	[HSE guidance not available]	—

Table 2. Principal UK workplace legislation requirements	
Requirement no.	**Subject**
5	Maintenance of workplace, and equipment, devices and systems
6	Ventilation
7	Temperature in indoor workplaces
8	Lighting
9	Cleanliness and waste materials
10	Room dimensions and space
11	Workstations and seating
12	Condition of floors and traffic routes
14	Windows, and transparent or translucent doors, gates and walls
15	Windows, skylights and ventilators
16	Ability to clean windows etc. safely
17	Organization etc. of traffic routes
18	Doors and gates
19	Escalators and moving walkways
20	Sanitary conveniences
21	Washing facilities
22	Drinking water
23	Accommodation for clothing
24	Facilities for changing clothing
25	Facilities for rest and eating meals

[1)] In preparation.

10.3 Building control legislation

NOTE 1. For issues concerning people in the various forms of the workplace, see **10.1**. This subclause concerns controls placed on the form and construction of IT accommodation.

Primary legislation is contained in The Building Act 1984 [29] empowering the making of building regulations and controlling other related matters. Those powers include matters relating to the protection of people in and about buildings against fire, that being a subject of continuing control in designated classes of buildings.

In the United Kingdom, The Building Act 1984 [29] applies to England and Wales. Legislation covering the same fields, but expressed differently, exists for Scotland, and for Northern Ireland.

The purpose of The Building Regulations 1991 [30] is limited to:

a) securing the health, safety, welfare and convenience of persons in or about buildings and others who may be affected by buildings or matters connected with buildings;

b) furthering the conservation of fuel and power;

c) preventing waste, undue consumption, misuse or contamination of water.

The Building Regulations have to some degree or another been drawn up with respect to the design and construction of buildings and the provision of services, fittings and equipment in or connected with buildings.

NOTE 2. The Building Regulations (SI 1991 No 2768 (amended by SI 1994 No 1850 and SI 1995 No 1365)) [30] apply to England and Wales; their scope is covered in Scotland and Northern Ireland in differently expressed documents.

The Building (Scotland) Act, 1959 [31] is the primary legislation in Scotland. Part 11 empowers the Secretary of State to prescribe standards. Regulations made under the Act are the Building Standards (Scotland) Regulations 1990 [39].

The Building Regulations (Northern Ireland) Order 1979 [32] conferred powers on the Department of the Environment (Northern Ireland) to make building regulations, the principal document being the Building Regulations (Northern Ireland) 1994 [33].

10.4 Continuing fire safety legislation

In respect of fire precautions, continuing control in designated buildings is exercised through the Fire Precautions Act 1971 (as amended) [34]. The Workplace (Fire Precautions) Regulations [38] administered by the Fire Authorities, also apply here.

Protocol establishes that, in respect of fire precautions, the building control authority is the lead authority at the design and construction stage (with a duty to consult the fire authority) and that for occupied buildings the lead body in respect of fire precautions is the fire authority.

Provided all relevant details are disclosed at the time of application, the Fire Precautions Act [34] bars the fire authority from requiring further structural precautions to be taken as a condition of the issue of a fire certificate where plans have been passed under building regulations showing the works to be executed for occupation.

10.5 Legislation controlling services

Services, comprising water, gas, electricity and telecommunications are subject to legislative control, setting conditions for their safe provision relating to the pipes and cables of the supplied service.

Electricity is probably the service of most concern. Guidance on installations is provided in BS 7671. Electrical installations are controlled by building regulations in Scotland, but not in England, Wales and Northern Ireland.

Electrical installations generally are regulated through the Electricity Supply Regulations 1988 (as amended) (SI 1988 No. 1057 [20], and SI 1995 No. 3021 [21]). The Electricity at Work Regulations (EAWR) 1989 [22] apply to places of work activity; enforcement rests with the Health and Safety Commission.

Gas services are subject to the Gas (Installation and Use) Regulations [35].

Water services are regulated by the Water Services Act [36] and the Water Supply Companies Byelaws.

11 Health and safety considerations

11.1 General

In considering the health and safety of persons who will use and maintain the accommodation and will work with the IT and business equipment, reference should be made to legislative requirements which will apply (see clause **10**).

In deciding to what extent provision for any particular facility or measure should be made, see BS 8800 which is particularly helpful in ensuring that a working Health and Safety system is maintained.

11.2 Health and safety features

The following features are listed as an indicator of common requirements. Specific accommodation will almost always require other factors to be taken into account. This list, therefore is not exhaustive.

a) Provision and regular maintenance of such facilities as are needed to satisfy Health and Safety legislation.

b) Preventative and scheduled maintenance of services such as air movers, gas, water, oil, coolant, electricity and air handling equipment (see clause **13**).

c) Access to and egress from the accommodation, particularly during emergency evacuation (see **5.10**).

d) Correct illumination for all the tasks to be undertaken (including any necessary use of special and moveable lighting) (see clause **7**).

e) Low contrast, low reflectance surfaces, decor and fitments which are free of hazards (see clause **7**).

f) Safety signs and notices correctly and visibly placed.

g) Provision of barriers for use during work which could present danger to the operations staff.

h) Fire equipment, alarms etc.

NOTE. Refer to the Workplace (Fire Precautions) Regulations [38].

i) Adequate fixed and/or movable acoustical screening (see **6.4**).

j) Separate, secure storage with privileged access control for housing any associated substances or failed equipment which needs to be controlled (see **5.9**).

k) Provision of and access to any air conditioning plant so that it can be maintained and so as to prevent airborne biological or particulate contamination in use or during maintenance (see clause **13**).

l) Elimination of trip hazards by correct placement and use of furniture, ducts, false floors, routeing restraints etc.

m) Adequately provisioned workstations including desk space with adjustments to equipment, seating and furniture where the IT equipment is likely to be used for long periods (see **5.2**).

n) Sufficient volume of air to service human needs (see **6.1**).

o) Structures which aid safe handling such as medium height level shelving.

p) Adequate layout and storage to prevent the accumulation of obstructions by materials related to work in progress.

q) Provision for personal security such as emergency alarm positions, security intercoms, cameras etc.

r) Controlled extension, adaptation or modification of accommodation: its structures, physical, electrical, environmental, cabling and other systems.

12 Security

12.1 Introduction

There are several different aspects of security that may need to be taken into account when making decisions about accommodation, environment and installation issues and features.

Broadly, they include the following:

a) measures to protect data and systems against corruption or unauthorized access and to ensure that they can be consistently and reliably installed or created, stored, updated, recalled and deleted;

b) measures to protect personnel, premises, property, data, media and software against crime (including theft or fraud) and to prevent unauthorized access;

c) measures to identify other risks and protection against them;

d) measures for physical and electronic protection where applied to both IT equipment and the facility.

NOTE. For recommendations on protection of IT equipment see Combating Computer Theft – Police/Business Joint Action Group [72].

12.2 General considerations

To identify the provisions needed in each case a Risk Assessment should be carried out early in the design process (see **4.2**). This will identify those aspects in **12.1** which will affect the installation, environment and accommodation concerned. It will also address the consequences of any foreseeable loss, damage, corruption or similar incident on the business concerned.

Such analysis then indicates a value to be protected and a potential scale of appropriate measures.

Reference should be made to BS 7799 for detailed guidance on the security of IT networks and other IT equipment operations, or to DISC PD 0007, the management guide to the use of BS 7799 by those responsible for security provisions.

Advice should be sought from specialists such as local crime prevention officers, architects and insurance companies on the physical aspects of safeguarding property (see **5.11**).

12.3 Key controls for information security

BS 7799 and DISC PD 0007 identify the key controls that are either essential requirements or considered to be fundamental building blocks for information security. Reference to BS 7799 and DISC PD 0007 is essential. The key controls are:

a) information security policy document;

b) allocation of information security responsibilities;

c) information security education and training;

d) reporting of security incidents;

e) virus controls;

f) business continuity planning process;

g) control of proprietary software copying;

h) safeguarding of organizational records;

i) data protection;

j) compliance with security policy;

k) disaster recovery plan.

13 Maintenance

13.1 General

The cleaning and maintenance of any building should be carried out to ensure a safe and healthy environment and to maintain the value of the investment in the building. Generally the requirements for cleaning and maintenance of buildings in which IT equipment is used are little different from other buildings.

Information on arranging cleaning and maintenance of most buildings can be found in BS 6263 : Part 2, BS 6270 : Parts 1 to 3, BS 8210 and BS 8213 : Part 1. These documents should be consulted when arranging for cleaning and maintenance of the IT environment.

Consideration should be given to the maintenance and running costs of the systems in particular in association with the Risk Assessment (see **4.2** and **12.2**).

NOTE. Additional information on cleaning and maintenance can be found in Technical Memorandum TM 17 Maintenance Management for Building Services – CIBSE [10].

13.2 Building

13.2.1 *Filtration*

See **6.2.2.7** for guidance on dedicated IT rooms.

13.2.2 *Equipment (dedicated IT rooms)*

When a part or the whole of a building is dedicated to an IT installation, special attention to various aspects of cleaning and maintenance may be necessary. The following paragraphs indicate some of these special precautions.

Vacuum cleaners should be kept in a clean condition and have filtration to 95 % efficient when tested in accordance with BS 3928. Consideration should be given to provision of a total extract vacuum system.

All cleaning materials used should not be detrimental to the surfaces to be cleaned or to the equipment within the IT room. They should be of a non-shedding type so as not to generate particulate contamination.

13.2.3 *Mechanical ventilation system*

The hygiene and treatment of humidification and dehumidification systems and wet cooling towers should receive careful and regular attention, to prevent the possibility of bacterial infections, e.g. legionella.

The cleanliness of ductwork is of increasing importance.

NOTE. The Health and Safety Commission's Workplace Health, Safety and Welfare Approved Code of Practice [46] sets out requirements for the cleaning, testing and maintenance of mechanical and natural ventilation systems in new, existing or modified buildings.

13.3 Staff

People should be instructed and trained to ensure that cleanliness is maintained. Typically, problems often arise from failure to use the designated entry and propping open doors. Eating, drinking and smoking in dedicated IT rooms should be prohibited.

13.4 Services

13.4.1 *New works*

The main contractor should be responsible for providing specialist cleaners to provide a final clean after new works are completed. This should also include beneath raised floors and above suspended ceilings together with access routes used in construction.

13.4.2 *General cleaning*

This should be carried out on at least a three monthly basis, subject to local conditions which may require more frequent cleaning.

13.4.3 *Chemicals*

Toxic, corrosive and explosive chemicals should be kept away from the IT rooms.

NOTE. Specific requirements for laboratories or manufacturing areas are not covered within this guide.

13.5 Maintenance procedures

Typical maintenance procedures for the various systems in an IT installation environment are as follows:

a) to regularly maintain air conditioning plant and record dust level counts at relevant particle size (see **6.2.2.7**);

NOTE 1. Additional precautions may be required if oxide particles are present.

b) to test equipment earthing annually or when a major change in the wiring distribution is undertaken. See BS 7671;

NOTE 2. Refer to FEI Guide on Recommendations for periodic inspection and testing of Information Technology and Business Equipment [15].

c) to maintain and test the emergency generator, if installed, every month. The test should be carried out on load, i.e. the IT equipment itself or a suitable dummy load;

d) to ensure that lighting and emergency alarms conform to the following:

1) BS 5266 : Part 1 which gives recommendations on emergency lighting;

2) BS 5839 : Part 1 which gives recommendations on installing and servicing fire alarms;

3) BS 4737 : Part 4: which gives recommendations on intruder alarms;

4) BS 7042 which gives recommendations on high security alarms;

5) BS 5306 : Part 0 to Part 7 which gives recommendations on fire fighting systems.

List of references (see clause 2)

Normative references

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BRITISH STANDARDS INSTITUTION, London

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BS 5295 : Part 2 : 1989	*Method for specifying the design, construction and commissioning of clean rooms and clean air devices*
BS 6100 :	*Glossary of building and civil engineering terms*
BS 6100 : Part 0 : 1992	*Introduction*
BS 6396 : 1995	*Specification for electrical systems in office furniture and office screens*
BS 6399 :	*Loading for buildings*
BS 6399 : Part 1 : 1984	*Code of practice for dead and imposed loads*
BS 7671 : 1992	*Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition*
BS 7799 : 1995	*Code of practice for information security management*
BS ISO/IEC 2382 :	*Information technology. Vocabulary*
BS ISO/IEC 2382 : Part 1 : 1993	*Fundamental terms*
BS EN 29241 :	*Ergonomic requirements for office work with visual display terminals (VDTs)*
BS EN 29241 : Part 1 : 1993	*General introduction*
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BS 4783 : Part 1 : 1988	*Recommendations for disk packs, storage modules and disk cartridges*
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BS 4783 : Part 6 : 1993	*Recommendations for optical disk cartridges (ODC)*
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BS 5266 :	*Emergency lighting*
BS 5266 : Part 1 : 1988	*Code of practice for the emergency lighting of premises other than cinemas and certain other specified premises used for entertainment*
BS 5295 :	*Environmental cleanliness in enclosed spaces*
BS 5295 : Part 1 : 1989	*Specification for clean rooms and clean air devices*
BS 5306 :	*Fire extinguishing installations and equipment on premises*
BS 5306 : Part 0 : 1986	*Guide for the selection of installed systems and other fire equipment*
BS 5306 : Part 1 : 1976	*Hydrant systems, hose reels and foam inlets*
BS 5306 : Part 2 : 1990	*Specification for sprinkler systems*
BS 5306 : Part 3 : 1985	*Code of practice for selection, installation and maintenance of portable fire extinguishers*
BS 5306 : Part 4 : 1986	*Specification for carbon dioxide systems*
BS 5306 : Part 5 :	*Halon systems*
BS 5306 : Part 5 : Section 5.1 : 1992	*Specification for halon 1301 total flooding systems*
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BS 5306 : Part 6 :	*Foam systems*
BS 5306 : Part 6 : Section 6.1 : 1988	*Specification for low expansion foam systems*
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BS 5306 : Part 7 : 1988	*Specification for powder systems*
BS 5588 :	*Fire precautions in the design, construction and use of buildings*
BS 5588 : Part 1 : 1990	*Code of practice for residential buildings*
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BS 5839 :	*Fire detection and alarm systems for buildings*
BS 5839 : Part 1 : 1988	*Code of practice for system design, installation and servicing*
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BS 5925 : 1991	*Code of practice for ventilation principles and designing for natural ventilation*
BS 5954 : 1980	*Specification for dimensions of panels and racks for electronic equipment*

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BS 8210 : 1986	*Guide to building maintenance management*
BS 8213 :	*Windows, doors and rooflights*
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